Appendix G. Benefit-cost Analysis

This appendix was prepared by HLB Decision Economics, Inc. It provides an analysis of the scenario/options in comparison to A1 and a description of the benefit-cost framework, assumptions, and theory. The scenario/options are evaluated for the low, medium, and high cost bridge estimates.

No-bridge alternatives

Before beginning a discussion of bridge alternatives and the estimation of benefits to bridge users, it is necessary to compare two aviation-only alternatives under Scenario A:

- Option A1: Keep all three airports Open; and
- Option A2: Close Naknek Airport in 2006.

Option A1 constitutes the base case against which all other options were evaluated. Option A2 assumes the closure of Naknek Airport in 2006. Expenditures for Operations and Maintenance as well as for Capital Improvements required to continue operations at King Salmon and South Naknek are included in Option A2. Table 1 presents the net savings of Option A2 over Option A1.

Table 1. Summary of Value of Naknek Crossing Options

(IN MILLIONS OF CONSTANT 2003 DOLLARS)

SAVINGS RELATIVE TO OPTION A1 (FULL AVIATION ONLY IMPROVEMENTS)

Option	O & M Cost Savings	Capital Cost Savings	Total Savings
Option A2: Close Naknek in 2006	$ 0.4	$ 14.0	$ 14.4

All subsequent estimations of benefits for the variations of bridge Scenario B are also presented *relative to the A1 base case*.

What are "user benefits?"

Direct standard of living and productivity gains to persons making river crossings are called "*user benefits*" to distinguish them from other more indirect benefits, such as economic development, that may accrue to persons who may not cross the river at all or to the community or region as a whole. The primary user benefits of construction of a bridge spanning the Naknek River at Fishery Point will arise in two principal categories. The first category includes those existing travelers who currently make river crossings via the various modes currently available: air taxi, private plane, skiff or other boat, snowmachine and "other vehicles," which includes cars and trucks making the crossing when the river freezes sufficiently to support the vehicle's weight. Time savings and reduction in out-of-pocket travel costs benefit existing travelers as a result of the quicker and less expensive provided by the bridge.

Benefits in the second principal category arise in the form of additional trip making to and from South Naknek and neighboring areas by auto and truck users for whom the costs of access prior to the improvement outweighed the value of opportunities on the other side. Such opportunities can include existing draws such as shops, work places, and social and recreational activities. As well, new opportunities can emerge in response to the new cost-to-value travel equation, leading to yet further "*induced demand*." The sum of all projected benefits, by category, is given in Table 2 through Table 4. As the tables shows, with benefits ranging from $74 million to $184 million (in constant dollars) over the period 2004 to 2029, all the bridge options and under all of the assumptions offer significant net economic gains. The three pie charts shown in Figure 1 demonstrate that the preponderance of benefits in every case comes from induced trips rather than existing trips.

Figure 2 presents the relationship between the benefits for existing travelers and benefits arising from induced demand. Due to fact that the estimated bridge traffic is up to 34 times greater than estimates for current crossing levels, the benefits from induced demand are in turn many times greater than for existing travelers.

Table 2. Summary of user benefits by option, high bridge cost

SUMMARY OF VALUE OF NAKNEK CROSSING OPTIONS (IN MILLIONS OF CONSTANT 2003 DOLLARS)

RELATIVE TO OPTION A1 (AVIATION ONLY IMPROVEMENTS)

High Bridge Cost Option

Option	Travel Cost Benefits			Borough Savings from Facility Consolidation (Midpoint Estimate)	NET Airport and Bridge Operating Cost Savings	Total Project Benefits
	Existing Trips	Induced Trips	Grand Total (Consumer Surplus)			
Build Traffic Forecast Assumption				$ 5.21		
Base Case	$ 9.49	$ 105.39	$ 114.88			
Low Case	$ 9.49	$ 64.71	$ 74.20			
High Case	$ 9.49	$ 174.13	$ 183.61			
Option B1: All Airports Open					$ (0.04)	
Base Case						$ 114.84
Low Case						$ 74.16
High Case						$ 183.57
Option B2: Close Naknek in 2009					$ 0.26	
Base Case						$ 115.14
Low Case						$ 74.46
High Case						$ 183.88
Option B3: Close South Naknek in 2009					$ 0.20	
Base Case						$ 115.07
Low Case						$ 74.39
High Case						$ 183.81
Option B4: Close Naknek and South Naknek in 2009					$ 0.53	
Base Case						$ 115.40
Low Case						$ 74.72
High Case						$ 184.14

Table 3. Summary of user benefits by option, medium bridge cost

SUMMARY OF VALUE OF NAKNEK CROSSING OPTIONS (IN MILLIONS OF CONSTANT 2003 DOLLARS)

RELATIVE TO OPTION A1 (AVIATION ONLY IMPROVEMENTS)

Medium Bridge Cost Option

Option	Travel Cost Benefits			Borough Savings from Facility Consolidation (Midpoint Estimate)	NET Airport and Bridge Operating Cost Savings	Total Project Benefits
	Existing Trips	Induced Trips	Grand Total (Consumer Surplus)			
Build Traffic Forecast Assumption				$ 5.21		
Base Case	$ 9.49	$ 105.39	$ 114.88			
Low Case	$ 9.49	$ 64.71	$ 74.20			
High Case	$ 9.49	$ 174.13	$ 183.61			
Option B1: All Airports Open					$ (0.53)	
Base Case						$ 114.34
Low Case						$ 73.66
High Case						$ 183.08
Option B2: Close Naknek in 2009					$ (0.23)	
Base Case						$ 114.65
Low Case						$ 73.97
High Case						$ 183.39
Option B3: Close South Naknek in 2009					$ (0.30)	
Base Case						$ 114.58
Low Case						$ 73.90
High Case						$ 183.32
Option B4: Close Naknek and South Naknek in 2009					$ 0.03	
Base Case						$ 114.91
Low Case						$ 74.23
High Case						$ 183.65

Table 4. Summary of user benefits by option, low bridge cost

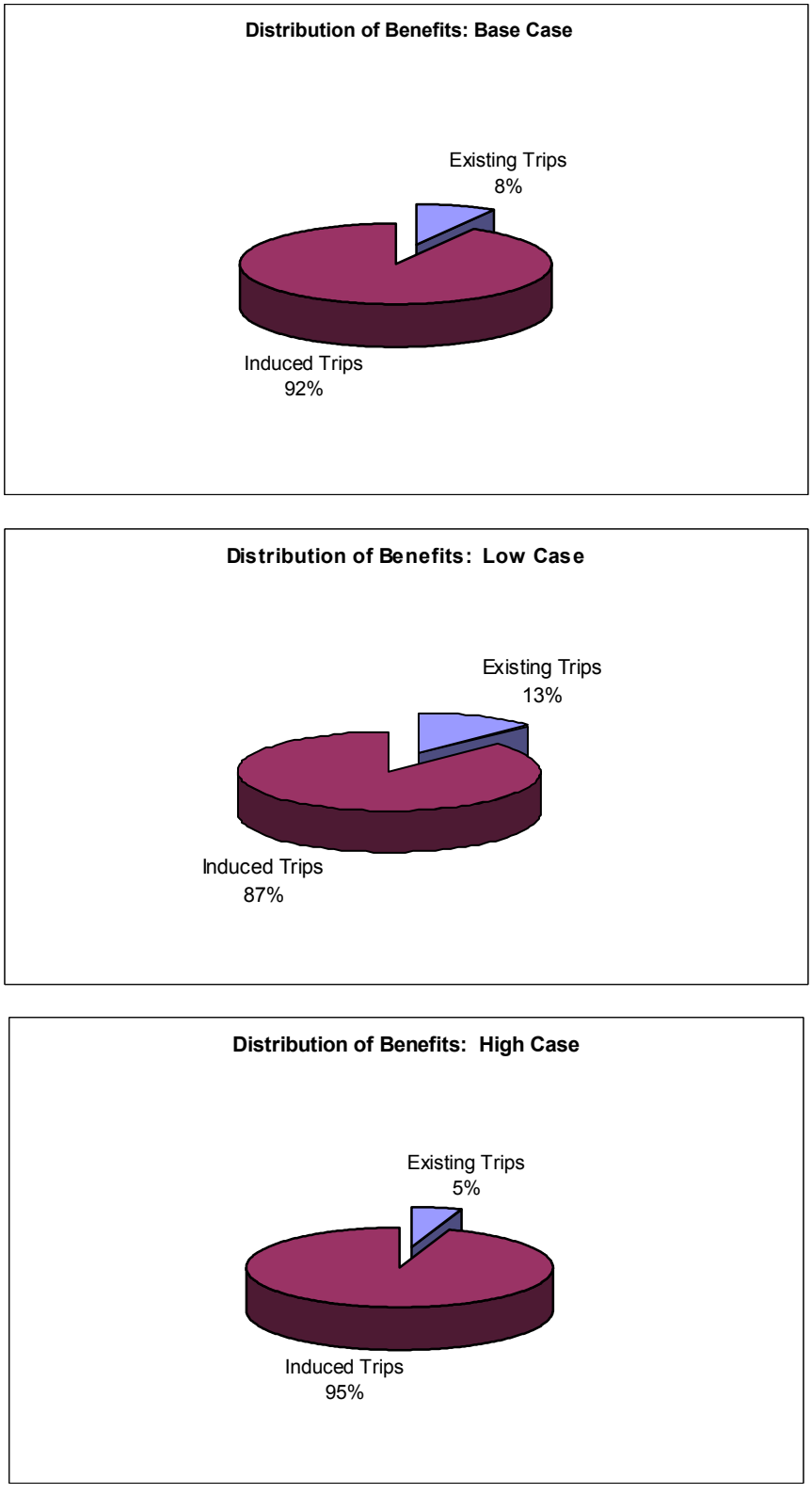
SUMMARY OF VALUE OF NAKNEK CROSSING OPTIONS (IN MILLIONS OF CONSTANT 2003 DOLLARS)

RELATIVE TO OPTION A1 (AVIATION ONLY IMPROVEMENTS)

Low Bridge Cost Option

Option	Travel Cost Benefits			Borough Savings from Facility Consolidation (Midpoint Estimate)	NET Airport and Bridge Operating Cost Savings	Total Project Benefits
	Existing Trips	Induced Trips	Grand Total (Consumer Surplus)			
Build Traffic Forecast Assumption				$ 5.21		
Base Case	$ 9.49	$ 105.39	$ 114.88			
Low Case	$ 9.49	$ 64.71	$ 74.20			
High Case	$ 9.49	$ 174.13	$ 183.61			
Option B1: All Airports Open					$ (0.53)	
Base Case						$ 114.34
Low Case						$ 73.66
High Case						$ 183.08
Option B2: Close Naknek in 2009					$ (0.23)	
Base Case						$ 114.65
Low Case						$ 73.97
High Case						$ 183.39
Option B3: Close South Naknek in 2009					$ (0.30)	
Base Case						$ 114.58
Low Case						$ 73.90
High Case						$ 183.32
Option B4: Close Naknek and South Naknek in 2009					$ 0.03	
Base Case						$ 114.91
Low Case						$ 74.23
High Case						$ 183.65

Figure 1. Distribution of Benefits from Existing and Induced Crossings, All Cases



Key assumptions

Key assumptions and data sources for the user benefits estimation are shown in Table 5.

Table 5. BENEFIT/COST ANALYSIS ASSUMPTIONS AND SOURCES

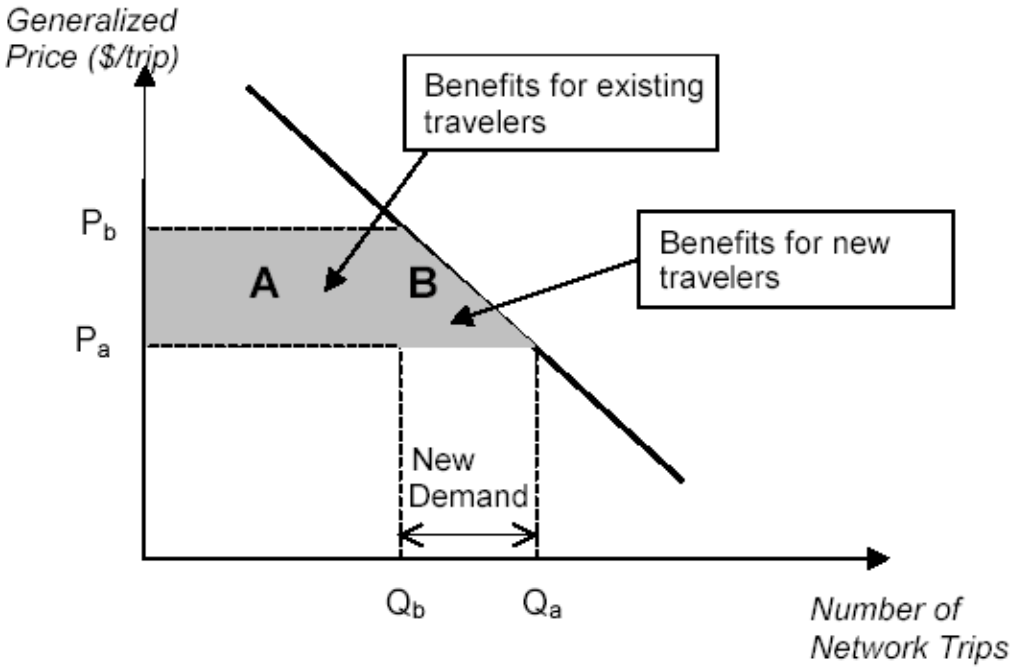
ITEM	VALUE	SOURCE
VALUE OF TIME, $ per HOUR PER PASSENGER		
Personal Cars	$13.86	Federal Highway Administration, *Highway Economic Requirements System Technical Report*, U.S. Department of Transportation, December 2000; U. S. Department of Transportation, "The Value of Saving Travel Time: Departmental Guidance for Conducting Economic Evaluations," April 1997, Table 4.
Trucks	$23.75	
Bristol Bay Salary as a % of National Average	100%	
VEHICLE OPERATING COSTS		
Air Taxi (Fare)	$36.00	Northern Economics / Ivan Moore Research Survey January 2-5, 2004
Personal Cars/Snowachine		Snowmachine costs assumed equivalent to private cars.
Fuel, $ per gallon	$2.00	AAA, Daily Fuel Gauge Report, adjusted for local prices per http://www.state.ak.us/local/akpages/ADMIN/dgs/cam/temppdf/8fuels.pdf
Oil, $ per quart	$4.23	Federal Highway Administration, Highway Economic Requirements System Technical Report, U.S. Department of Transportation, December 2000; J.P. Zaniewski, et.al., Vehicle Operating Costs, Fuel Consumption, and Pavement Type and Condition Factors, Texas Research and Development Foundation, prepared for U.S. Department of Transportation, Federal Highway Administration, Washington, D.C., June 1982, Table 2, p. 7.
Tire, $ per tire	$74.09	
M&R, $	$120.82	
Depreciable Value, $	$21,159.14	Federal Highway Administration, Highway Economic Requirements System Technical Report, U.S. Department of Transportation, December 2000.
Total VOC Per Vehicle Mile	$0.3600	
Trucks		
Fuel, $ per gallon	$2.00	AAA, Daily Fuel Gauge Report.
Oil, $ per quart	$1.69	Federal Highway Administration, Highway Economic Requirements System Technical Report, U.S. Department of Transportation, December 2000; J.P. Zaniewski, et.al., Vehicle Operating Costs, Fuel Consumption, and Pavement Type and Condition Factors, Texas Research and Development Foundation, prepared for U.S. Department of Transportation, Federal Highway Administration, Washington, D.C., June 1982, Table 2, p. 7.
Tire, $ per tire	$487.78	
M&R, $	$421.02	
Depreciable Value, $	$94,933.01	Federal Highway Administration, Highway Economic Requirements System Technical Report, U.S. Department of Transportation, December 2000.
Total VOC Per Vehicle Mile	$0.980	
Private Aircraft - Per Hour, Fuel Price @$2.62/gallon	$163.00	Conkin & Decker Aircraft Cost Evaluator (http://www.aso.com/cda/main/)
Boat/Skiff - Per Hour	$50.00	HLB Decision Economics Estimate

ITEM	VALUE	SOURCE
DISCOUNT RATE FOR PRESENT VALUE CALCULATIONS	3.5%	Federal OMB Circular A-94, Appendix C, 30-Year, Revised February 2004 (http://www.whitehouse.gov/omb/circulars/a094/a94_appx-c.html)
BRIDGE AND AIRPORT COSTS		
Bridge and Airport Costs in 2003 Dollars		
Bridge Project Start Year	2004	
Bridge Completion Year	2009	
Bridge In Service Year	2010	
Analysis End Year	2025	
REAL DISCOUNT RATE	3.50%	OMB Circular A-94, Appendix C, Revised February 2004, 30-year (http://www.whitehouse.gov/omb/circulars/a094/a94_appx-c.html)
SCENARIO A (NO BUILD)	-2.750%	Annual Growth Rate in Crossings Forecast Equivalent to Low Case Scenario B Forecast
NUMBER OF PASSENGERS PER VEHICLE		
Air Taxi	1.70	
Private Plane	1.70	
Skiff or Boat	1.70	
Snowmachine	1.20	
Other Vehicle	1.70	
Personal Cars	1.70	
Trucks	1.00	
% Truck Traffic of Total (Scenario B - with Bridge)	5%	

Economic framework for measuring user benefits

The primary benefits of most highway and bridge infrastructure projects are benefits that infrastructure users realize through travel time savings and induced demand. The economic framework for measuring these benefits is illustrated in Figure 2 below. The classic economic demand and supply relationship is illustrated for cross-river travel, with the quantity of trips (Q) demanded at a given level of generalized price per trip (P). The generalized price included vehicle operating costs, airfares, the value of travel time including access and egress and so on. Under the status quo, users of the current modes demand Qb trips across the river at a generalized trip price Pb.

Figure 2. Methodology for Measuring Benefits of Bridge or Ferry Alternative



where:

Pb is the generalized trip price of the existing modes for trips that include a river crossing

Pa is the generalized trip price after the implementation of the bridge access

Qb is the number of trips with the existing modes

Qa is number of trips after implementation of the bridge access

Using the assumption that construction of the bridge results in a reduction in the generalized trip price Pa, we see in Figure 2 that the amount of trips demanded increases to Qa creating two distinct user benefits:

1) Reduced trip cost for existing travelers; and,

2) "Consumer surplus" from the new trips.

The reduced trip costs for existing travelers is represented by rectangular shaded area A of Figure 2. The consumer surplus from new trips, or the difference between what travelers are willing to pay relative to the amount travelers actually pay for new trips, is represented by triangular shaded area B of Figure 2.

What is included within consumer surplus and induced demand?

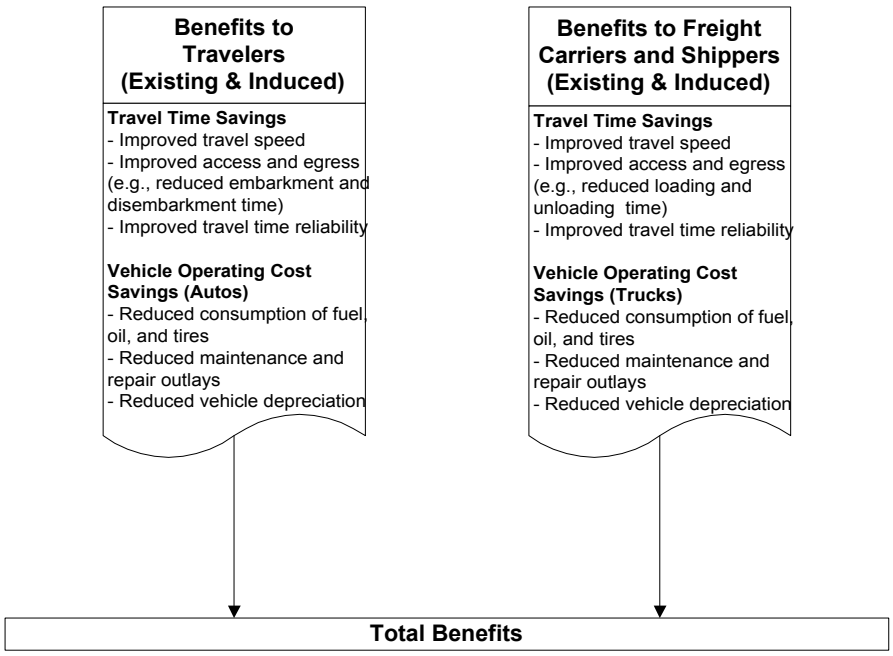
Although the economic benefits (highlighted in areas A and B of Figure ___) of improved access to South Naknek are measured here in terms of the monetary equivalent value of the time and operating costs to be saved by users of a prospective bridge, and the consumer surplus derived from new trips, it is important to note that the final economic manifestation of such benefits could arise partly in other forms. These other benefits could include stimulation of commercial and housing development on both sides of the river, increases in the value of land, addition of jobs from businesses whose transportation costs are significantly lower, costs savings to the Bristol Bay Borough from consolidation of services currently duplicated in both Naknek and South Nakek and so on. Estimates of the latter benefits have been made and are shown in Table 2 through Table 4 alongside the total consumer surplus, because these benefits are in effect already included in the consumer surplus. In fact, the large increase in the number of trips resulting from the bridge is in part due to residents traveling across the river to procure services such as education, library, and post office which no longer need to be provided on both sides of the river.

It is simply analytic convenience that leads transportation economists to measure the development value of better access through the lens of trip volumes, including new demand, and corresponding time savings. We know something of the trip generating effects of a new bridge in particular geographic circumstances. The alternative, namely to forecast the monetization of each acre of land development because of improved access, when, and so forth, requires a great deal more information and, more significantly, is a great deal less accurate.

Detail of benefits estimation methodology

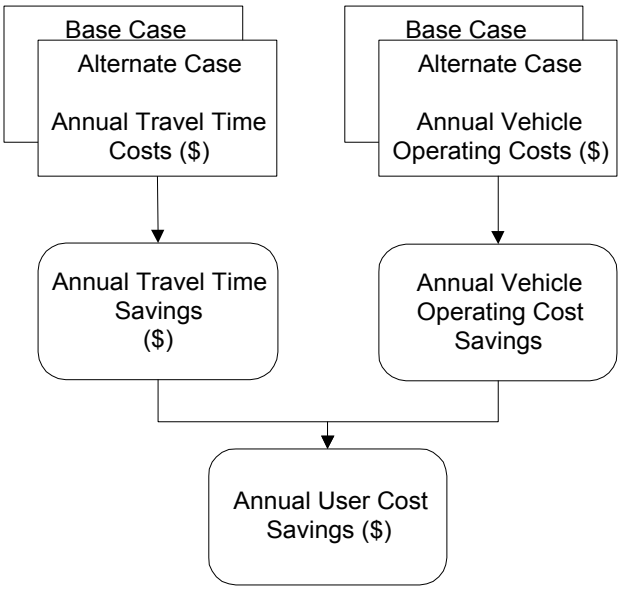
Figure 3 below illustrates a high-level structure and logic diagram describing the overall benefits framework for the access improvements highlighting the various cost elements that are considered in the analysis. For the both the base case (Scenario A) and the bridge alternative considered, a generalized cost per trip is estimated including travel time costs and vehicle operating costs. The methodology used in estimating each of the user cost components is described in the sections below.

Figure 3. Benefits estimation methodology



Travel time costs

Figure 4. Calculation of Travel Time Costs



Time costs figure prominently in the economic evaluation of transportation infrastructure projects. The potential time savings from even a minor improvement can translate into

significant user cost savings over the life of the investment, depending on the facility type and traffic characteristics. Travel time costs are derived by first calculating a value of time, for passenger cars and trucks. In urban settings, these values are adjusted for congestion, but in this rural setting it is not necessary to do so. These values of time, in dollars per hour, are then multiplied by the total trip time. These calculations are performed for all trips using the existing modes and included estimates of time to reach the airport, dock, etc.

"Out of pocket" travel expenses

Out of pocket travel expenses consist of vehicle operating costs for roadway traffic, snow machines, and private planes and airfares for crossings in air taxis. The mileages for all the existing modes and bridge traffic were estimated using area maps. Since crossings could have as their northern origin or destination either Naknek, King Salmon or other intermediate point, distances are an average of trips to each of the two major towns.

Truck and passenger car operating costs per mile are estimated for each access alternative using typical roadway speeds and fuel at $2.00 per gallon. Per mile rates are then multiplied by the average roadway trip length to derive a vehicle operating cost estimate per trip. Vehicle operating costs are an integral element of computing roadway user costs. They generally are the most recognized of the user costs because they typically involve the out-of-pocket expenses associated with owning, operating and maintaining a vehicle.
The unit costs are marginal costs, net of taxes, subsidies and other transfer payments. There are five cost components associated with operating a vehicle. They include: fuel consumption, oil consumption, maintenance and repairs, tire wear and roadway related vehicle depreciation.

Each component is a unique function of vehicle class and vehicle speed. Fares for air taxis are obtained from the travel survey which was used to estimate the bridge traffic. Operating costs for private planes are derived using an online estimator for a Piper Cherokee 140, selected as a representative aircraft in service between the study communities. For snow machines, it was assumed that the costs were roughly equivalent to automobiles, and skiffs and boats are costed at an estimated composite rate of $50 per hour.

Figure 5 on the following page shows the structure and logic of the user cost calculation. Table 6 on the page following Figure 5 presents the calculation of the travel cost for both Scenarios A and B.

Figure 5. Calculation of travel costs

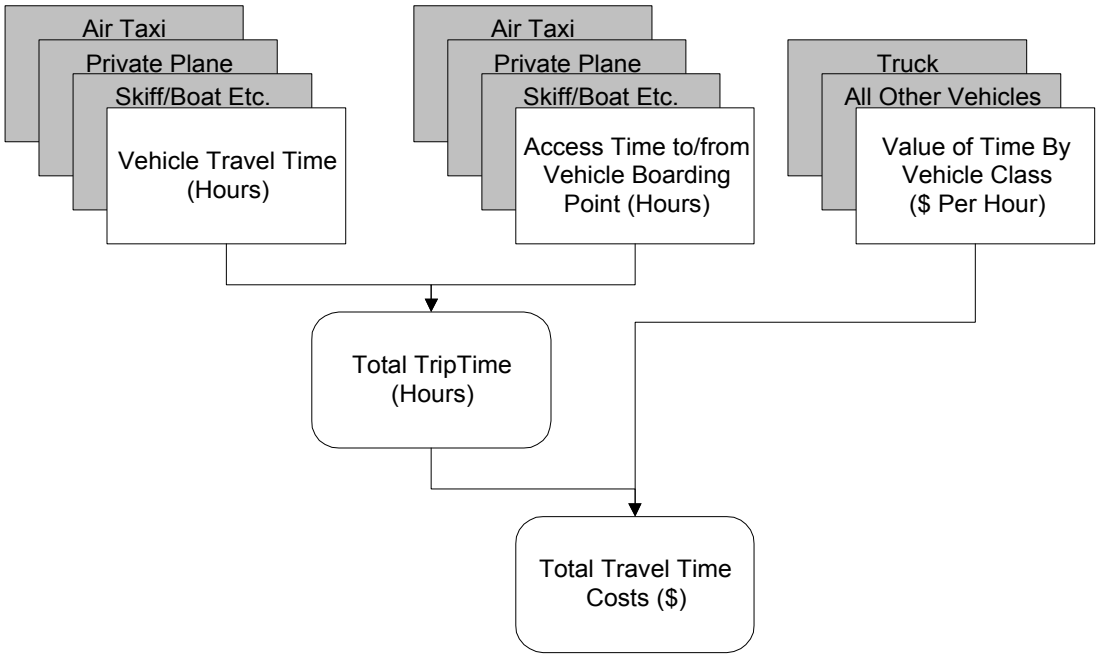


Table 6. Calculation of Travel Cost

Average Travel Cost per *PASSENGER Trip*, Dollars of 2003
Trips to/from South Naknek From Naknek and King Salmon, Non-weighted Average

Personal Travel	Mode	Travel Time (hours)	Total Trip Length (miles)	Total Time Costs ($)	Average Roadway Vehicle Speed	Unit VOC ($) (Fare or Per Mi or Hr)	Total VOC ($)	Percent Distribution	Total Cost per Trip ($) Per Passenger	Weighted Total Costs ($)	Percentage Change in Costs (%)	Avg. Passenger per Vehicle
Option: Scenario A	Air Taxi*	0.67		$9.24		$36.0000	$36.00	30%	**$45.24**	$13.41		N/A
	Private Plane*	0.58		$8.09		$163.0000	$40.75	24%	**$28.73**	$6.87		1.70
	Skiff or Boat*	0.83		$11.55		$50.0000	$25.00	35%	**$21.50**	$7.56		1.70
	Snowmachine	0.50	15.50	$6.93		$0.3600	$3.28	3%	**$8.51**	$0.28		1.20
	Other Vehicle	0.50	15.50	$6.93		$0.3600	$3.28	8%	**$6.01**	$0.48		1.70
	Weighted Avg.							100%		$28.60		
										Change in Cost		
Scenario B - Base Case	Car**	0.31	15.50	$4.30	50.00	$0.3600	$3.28		**$4.46**	-$24.14	-84.41%	1.70
Scenario B - Low Case	Car**	0.31	15.50	$4.30	50.00	$0.3600	$3.28		**$4.46**			1.70
Scenario B - High Case	Car**	0.31	15.50	$4.30	50.00	$0.3600	$3.28		**$4.46**			1.70

*Includes 20 Minutes Access Time at Beginning and End of Trip
**Assumes 50 MPH Average Speed

Commercial / Truck Travel	Mode	Travel Time (hours)	Trip Length (miles)	Total Time Costs ($)	Average Roadway Vehicle Speed	Unit Roadway VOC ($)	Total VOC ($)	Change in Roadway VOC ($)	Total Cost per Trip ($)	Change in Total Costs ($)	Percentage Change in Costs (%)	Avg. Passenger per Vehicle
Option: Scenario A	None											
Scenario B - Base Case	Truck**	0.31	15.50	$7.36	50.00	$0.980	$15.19	Varies	**$22.55**	-$6.05		1.00
Scenario B - Low Case	Truck**	0.31	15.50	$7.36	50.00	$0.980	$15.19		**$22.55**			1.00
Scenario B - High Case	Truck**	0.31	15.50	$7.36	50.00	$0.980	$15.19		**$22.55**			1.00